Guidelines for Utah's Tier 1 Risk-Based Corrective Action:

Utah's Guide for Screening Petroleum-Contaminated Sites

prepared by the
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DRAFT FINAL

April 7, 1997

ERRATA

April 7, 1997

This errata sheet is provided to amend the final draft of Utah's Risk-Based Corrective Action (RBCA) Tier 1 screening guidance document dated September 29, 1995.

Page B1: The original version stated that UDEQ has selected a 10^{-4} target excess risk (TER) limit for carcinogenic compounds. This revision explains that Utah's Cleanup Policy requires receptors be protected to a 10^{-6} TER, MCLs, or other applicable standards. However, for screening purposes only, UDEQ has determined that according to conservative Tier 1 screening assumptions, contamination representing an equivalent 10^{-4} TER at the source area may generally attenuate to 10^{-6} TER limit within 30 feet of the source area. The revised language is as follows:

I. EXCESS RISK

Utah's Cleanup Policy requires that receptors be protected to MCLs or a 10^{-6} TER equivalent level. For Tier 1 screening purposes, however, the UDEQ has determined that contaminant levels representing a TER of 10^{-4} at the source area generally attenuate to a 10^{-6} level within 30 feet of the source area.

Page B4: Groundwater velocity, U_v, should be U_{darcy}, to indicate groundwater Darcy velocity and distinguish it from seepage or transport velocity. That portion of Table B.1 has been changed to the following:

U_{darcy} *	Groundwater Darcy Velocity (k X i)	cm/yr	2500	82 ft/yr	***1100***	***36***

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GUIDELINES FOR UTAH'S TIER 1 RISK-BASED CORRECTIVE ACTION (RBCA)

Utah's Guide for Screening Petroleum-Contaminated Sites

I. INTRODUCTION

The following guidelines are intended to assist owners/operators and the Division of Environmental Response and Remediation ("DERR") in the management of leaking underground storage tank ("LUST") sites in Utah. These guidelines provide a framework for incorporating risk-based decisions in LUST site management. These guidelines are subject to and intended to be consistent with Utah Administrative Code (UAC) R311-211, *Corrective Action Clean-Up Standards Policy - UST and CERCLA Sites* ("Utah's Cleanup Rules") and with EPA policy as set forth in *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, OSWER Directive 9610.17 (February 24, 1995) ("EPA Directive").

The EPA Directive states that the American Society for Testing and Materials' *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, (ASTM) ES 38-94 ("ASTM Guide") is "one possible starting point for development of a process using risk-based approaches described in this policy statement." The ASTM Guide was used as the starting point for the development of the following guidelines for Utah LUST sites, which are intended to be consistent with the ASTM Guide.

Understanding the relationship between the following guidelines and Utah's Cleanup Rules is critical. Utah's Cleanup Rules recognize that cleanup to generally applicable standards is not always reasonable for petroleum releases from underground storage tanks (see UAC R311-211-5(c). Utah's Cleanup Rules allow a risk-based analysis to determine a site-specific cleanup standard when the generally applicable cleanup standards are not reasonable (UAC R311-211-3 and -5(c). Reasonableness is based on consideration of impact or potential impact to public health and the environment, the cost of the cleanup, and the available technology (UAC R311-211-3). Before a site-specific cleanup standard may be considered the source of contamination must be removed (UAC R311-211-3). Finally, in determining cleanup standards, levels of contamination in groundwater, surface water, soils, or air will not be allowed to degrade beyond the existing contamination levels as determined through appropriate monitoring or the use of other data accepted by the Utah Solid and Hazardous Waste Control Board or the Executive Secretary (UST) as representative (UAC R311-211-4).

The risk-based corrective action process ("RBCA") set forth in the following guidelines requires an assessment of the risk the contamination presents to public health and the environment to make corrective action decisions. The RBCA process uses a two-tiered (Tiers 1 and 2) approach to evaluate risk at LUST sites. The following guidelines focus on Tier 1. Supplemental guidelines are

being developed for Tier 2. At Tier 1, after the source has been removed, site-specific conditions are assessed to determine whether the contamination has reached or will reach an exposure pathway or receptor in unacceptable concentrations. If the contamination does not exceed the Tier 1 screening levels and is not expected to reach a receptor via a complete exposure pathway, closure of the LUST site case file may be appropriate even though generally applicable cleanup standards have not been achieved. If the contamination has reached or can be expected to reach a receptor via a complete exposure pathway, subsurface investigation, additional risk assessment or cleanup (Tier 2) is required.

The following guidelines utilize screening levels as a tool to determine whether the contamination will reach an exposure pathway or receptor in concentrations that present a risk to human health and the environment. The screening levels are not meant to create a generally applicable cleanup standard. The cleanup standards for leaking underground storage tank sites are established under UAC R311-211.

II. RBCA TIER 1 OVERVIEW

Utah's RBCA Tier 1 process is described in Figure 1. The process ensures compliance with all applicable rules and replaces the DERR's former Phase1 Reporting and Remediation schedule in order to streamline and simplify the process. For example, the former Initial Abatement and Site Check requirements are equivalent to the RBCA Site Classification, and the former Site Characterization is equivalent to the RBCA Site Assessment. Utah's RBCA involves classifying the site, evaluating the Site Assessment Information, and determining if contaminant concentrations at the source are above or below the screening levels (see Table 1).

The RBCA Tier 1 Worksheet (Table 2) is used to evaluate the Site Assessment Information and screening levels. If contamination levels for all constituents are found to be below the screening levels and the contamination does not represent a threat to human health and the environment, the site case file can be closed out. In the case where exposure pathways or receptors are at risk, or when contamination levels are above the screening levels, the owner/operator has two options to pursue: (1) perform cleanup to applicable standards, or (2) perform a Tier 2 risk assessment and/or cleanup using site-specific data.

A. SITE ASSESSMENT INFORMATION

The RBCA Tier 1 process can only be applied to a LUST site when Site Assessment Information (see RBCA Tier 1 Worksheet, Table 2) is obtained from the release report, Closure Plan (including site map), Closure Inspection Report, Closure Notice, or other reports. This required information for the Site Assessment must include, at a minimum, the following: product type and amount released, cause of the release, source removal information, land use and surrounding neighborhood information, soil and groundwater information, distance to receptors, and contaminant concentrations at the source area. The Site Assessment Information must be submitted before a Tier 1 evaluation can proceed. A complete explanation of the above required information is outlined in section III.

B. SITE CLASSIFICATION

Site classification is a dynamic process for prioritizing LUST sites according to the degree of urgency and response needs, and is based on the current and potential degree and severity of hazards to human and environmental health. The owner/operator is responsible for providing site classification information and initiating the appropriate response actions. The Site Classification process ensures that the requirements of Utah's Cleanup Rules are met, and that, when maximum contaminant levels (MCLs) or other appropriate standards are exceeded, appropriate response actions will be taken to ensure that exposure pathways are not complete and that receptors are not exposed. Site classification enables the DERR project manager, the owner/operator, and the public to know what media and receptors are impacted or potentially threatened and what appropriate response actions are necessary. Site classification is dynamic and sites are re-classified as more information becomes available.

For each level of classification (see Appendix A for details), a corresponding recommended initial response action is provided. If direct and immediate threats to human health and the environment exist at the site, the site is a "Class 1" and the response actions outlined in Table A.1 must be implemented. A Tier 1 evaluation cannot proceed until the threat has been mitigated, controlled, and monitored.

The site classification scheme follows the ASTM Guide (1994) and provides a case-by-case evaluation of hazards to assure that all receptors are protected from the contamination to the maximum extent possible in accordance with Utah's Cleanup Rules (UAC R311-211). Site classification, combined with the Site Assessment information, ensures that all elements identified in UAC R311-211 are evaluated on a case-by-case basis. Because the screening levels are not intended to replace MCLs, at any Tier or under any condition, the site classification scheme ensures that current or potential receptors will not be exposed to concentrations exceeding the MCLs.

C. TIER 1 SCREENING LEVELS

After the DERR has classified the site and completed or reviewed the Tier 1 Worksheet and determined that there are no receptors or exposure pathways, contaminant concentrations at the source area are compared to the Tier 1 screening levels shown in Table 1 to determine if further actions are required at the site. Tier 1 screening levels represent contaminant concentrations at the source that are expected to be protective of human health and the environment, provided there are no exposure pathways or receptors. The screening levels shown in Table 1 were derived using conservative assumptions, Utah-specific conditions, known or recognized toxicological parameters, and contaminant migration and fate equations (see Appendix B). The screening level values were rounded to the first significant figure.

The exposed population scenario used to develop the Tier 1 screening levels found in Table 1 is residential. This conservative scenario is used because information concerning the

migration of the contamination from the source area is commonly not known at this level of data collection and analysis. Other exposed population scenarios may be considered during the Tier 2 evaluation. However, guideline and procedures have not been formulated for Tier 2 as of the date of this guideline.

Currently, risk-based screening levels cannot be developed for Total Petroleum Hydrocarbon (TPH) contamination. However, TPH does have toxic characteristics when released and poses a hazard to human health and the environment. The TPH screening levels were derived using general principles of the composition, fate, and transport of TPH, and aesthetic impacts to the environment.

D. TIER 1 WORKSHEET

The Tier 1 Worksheet is a tool used to evaluate the Site Assessment Information, and determine if Tier 1 screening levels have been met. Upon completion of the Tier 1 process, the DERR project manager uses the Worksheet to recommend any additional actions, if needed.

The Tier 1 Worksheet is used to evaluate Site Assessment Information and can be completed by the DERR project manager, the owner/operator, or the owner's representative. If the owner/operator or representative completes the Worksheet, the DERR will review the Worksheet to verify the information and provide an independent recommendation. If the DERR's recommendation is different than the owner/operator, the DERR will notify them and outline the circumstances by which the recommendation was made and why they differ.

Figure 1
Utah's RBCA Tier 1 Screening Process

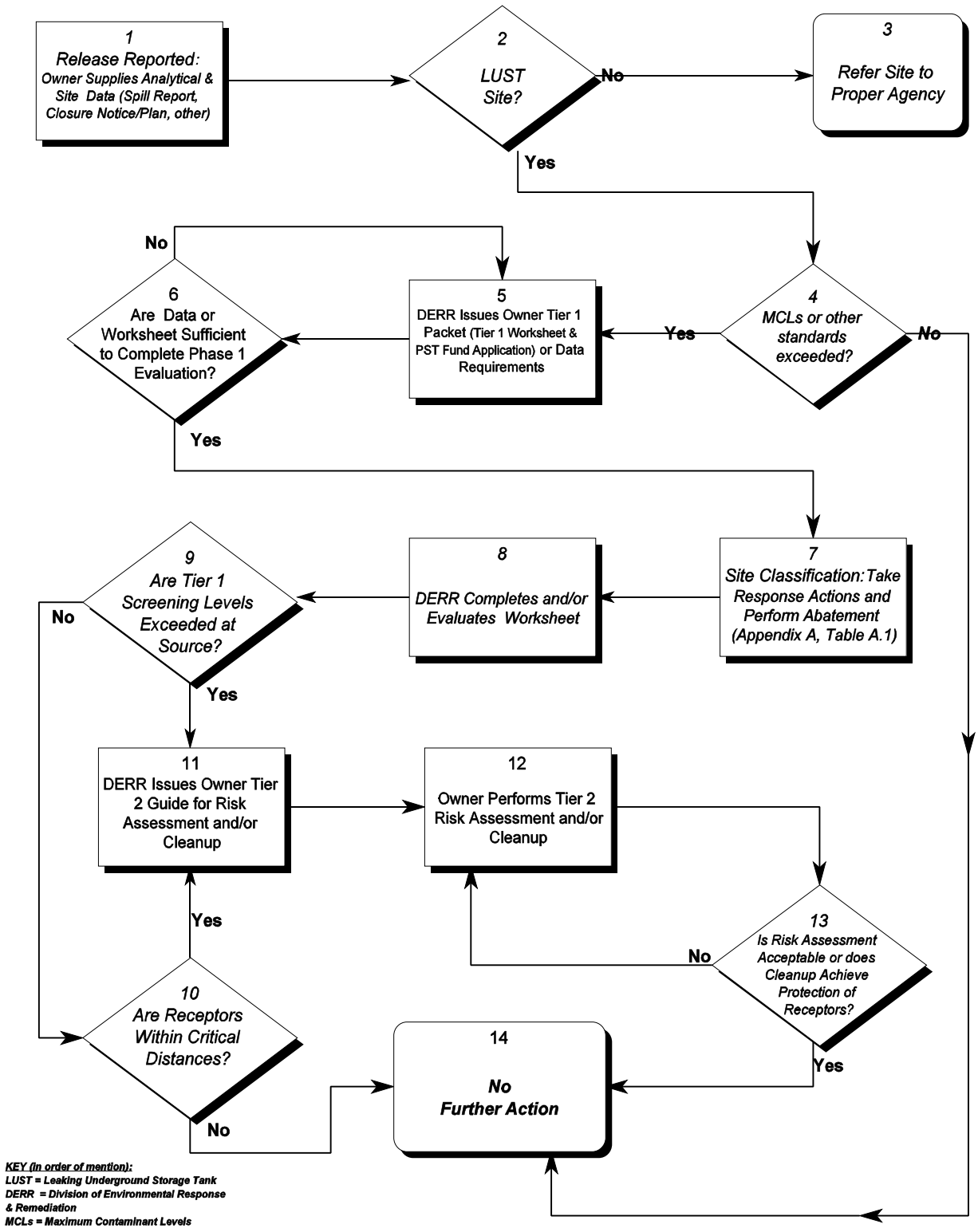

Table 1

TIER 1 SCREENING LEVELS

(These Screening Levels are applicable only when all Tier 1 criteria have been met)

		Column 1	Column 2
CONSTITUENT	**Analytical Method** (EPA, 1984)	**Groundwater** *(mg/L)*	**Soil** *(mg/kg)*
Benzene*	602/8020	0.3	0.9
Toluene*	602/8020	7	61
Ethylbenzene*	602/8020	4	23
Xylenes*	602/8020	73	235
Naphthalene*	602/8020	0.1	10
Methyl t-butyl ether (MTBE)	602/8020	0.2	0.3
Total Petroleum Hydrocarbons (TPH) as gasoline**	8015, mod.	10	1500
Total Petroleum Hydrocarbons (TPH) as diesel**	8015, mod.	10	5000
Oil and Grease or Total Recoverable Petroleum Hydrocarbons (TRPH) **	413.1 or 418.1	10	10000

* risk-based
** non-risk-based

Table 2

Utah's RBCA Tier 1 Worksheet

FACILITY INFORMATION

Facility Name

Location/Address (no Box Numbers)

Facility Owner Name Address (City/State/Zip Code)

Facility Owner Phone # Area Code Phone Number

(For DERR Use Only)

Facility ID. # _____
Release ID _____
Notification Date_____
Release Reported By_____

DERR Project Manager: _____
Person Completing Worksheet:_____

SITE ASSESSMENT INFORMATION

(For DERR Use Only)
a. Site Classification
(use Table A.1 for most precise classification)
Classification:_____
Impacts:_____
_____
Required Response Actions:
_____
_____

b. Contaminant Source Information

Product Released	Amount Released (gal)	Cause of Release (if known)
Gasoline	_____	___tank ___piping ___dispenser ___overfill/spill
Diesel	_____	___tank ___piping ___dispenser ___overfill/spill
Waste Oil	_____	___tank ___piping ___dispenser ___overfill/spill
Unknown	_____	___tank ___piping ___dispenser ___overfill/spill
Other	_____	___tank ___piping ___dispenser ___overfill/spill

Sources Removed: __tank __piping __dispenser __free product __contaminated soil

c. Land Use Information

Current Land Use at the Site: _____ residential _____ commercial _____ industrial
Surrounding Neighborhood: _____ residential _____ commercial _____ industrial
(***Note:*** *Surrounding land use is* ***Residential*** *if one or more residences share a common property line with the Facility)*

d. Soil Information

Depth to Contaminated Soil (feet below land surface): _____
Soil Type(s):_____ Depth (below land surface):_____
Method of Soil Type Identification (*check applicable*): _____Unified Soil Classification _____Geologist's description

e. Groundwater Information

Was groundwater present in excavations? ____Yes ___No Thickness of Free Product: _____
Depth to groundwater (feet below land surface):_____
Is groundwater impacted at any concentration: ____Yes ___No
Groundwater flow direction *(circle applicable)*: E, W, N, S, SE, SW, NE, NW ____Inferred? ___Measured?
Slope direction of surface topography *(circle applicable)*: E, W, N, S, SE, SW, NE, NW

f. Distance from Source to Nearest Potential Receptor

(If any receptors are within 30 feet you must go to Tier 2)

Receptors ***(enter distance to each in feet)***
Subsurface Utilities: ____Water line ____Sewer line ____Natural Gas _____Storm Drain ____Telephone
____Electrical ____ Other (specify)
____Property Line ____Buildings (specify type: ____Residence ____Commercial ___ other, specify)

For DERR Use Only
Distance to Other Receptors

(If any receptors are within 500 feet you must go to Tier 2)

Receptors Within 500 feet ***(enter distance to each in feet and attach water well data sheets and maps; show facility location on each)***
_____Municipal Well _____Domestic Well _____Irrigation Well
_____Surface water (*specify type: lake, stream, creek, river, wetland*):_____

FACILITY SITE MAP

The owner/operator must submit a facility site map, as close as possible to scale, indicating the north direction, and shows locations of the following properly labeled features:

- Current and/or former UST systems (indicate product type for each)
- Utility lines (underground)
- Buildings or other structures
- Excavations
- Soil stockpiles
- Location of the release and known contamination
- Property lines
- Monitoring wells
- Sample locations

SUPPLEMENTAL INFORMATION

_____

_____

_____

Owner/Operator Must Submit Copies of Laboratory Analytical Data

RBCA TIER 1 SCREENING LEVEL EVALUATION
(For DERR Use Only)

	Groundwater (mg/L)		Soil (mg/kg)	
CONSTITUENT	**Screening Level**	**Highest Concentration at Source**	**Screening Level**	**Highest Concentration at Source**
Benzene	0.3		0.9	
Toluene	7		61	
Ethylbenzene	4		23	
Xylenes	73		235	
Naphthalene	0.1		10	
Methyl t-butyl ether (MTBE)	0.2		0.3	
TPH-gasoline	10		1500	
TPH-diesel	10		5000	
Oil and Grease/TRPH	10		10000	

RECOMMENDED TIER 1 ACTIONS
(For DERR Use Only)

	All contaminant concentration levels are below Tier 1 screening levels, and no receptors are within the critical distances. *Recommendation* - No further action.
	Contaminant concentration(s) exceed Tier 1 screening levels, or receptors are within applicable critical distances. *Recommendation* - Perform a Tier 2 risk assessment or cleanup to applicable levels.
	All contaminant concentrations are below Tier 1 screening levels but receptors are within the critical distances. *Recommendation* - Clean up to applicable levels.

Evaluation Completed by: _____ Date: _____
Signature

_____ Date: _____
Signature of Person Completing Tier 1 Worksheet if different from DERR Project Manager

III. UTAH'S TIER 1 RBCA SCREENING PROCEDURES

The sequence of tasks and decisions associated with the RBCA Tier 1 screening process are outlined on the flow chart in Figure 1. Each of these tasks and decisions are discussed below:

Step 1: Release Reported, Owner/Operator Supplies Data

The owner/operator is required to report to the DERR petroleum releases from their facility within 24 hours of discovery, in accordance with UAC R311-202 (UST Technical Standards). The DERR provides a Release Report form (Appendix D) to record important information concerning the release and its impacts. A DERR project manager receiving the release report obtains as much information about the release as possible from the reporting party in order to assist owners/operators in expediting abatement and cleanup of the contamination and proceeding with the Tier 1 screening process. Some of the Release Report information includes: owner information; site location; Petroleum Storage Tank Fund eligibility; current land use at the site and surrounding neighborhood; cause, source, and detection methods of the release; type and amount of contaminant released; impacts to receptors; measures taken to abate the release; soil and groundwater affected by the release. The Tier 1 Worksheet is also a useful tool for owners/operators when collecting and reporting data.

Data supplied in the Release Report form, Worksheet, or other reports are used to initially classify and prioritize the site (Step 7, below, Appendix A). The more information known and reported, the more accurate the site classification and degree of certainty concerning the immediacy of threats to human health and the environment. If an emergency situation exists (potential explosion or vapor hazard, drinking water supply impacted, etc.), the site is a Classification 1 and the DERR will require immediate corrective actions to abate, control, or prevent threats to human health and the environment and risk to receptors. Sites for which little data are provided are considered a Class 2.0.

Steps 2 and 3: Determination of Regulatory Authority

If a determination is made that the petroleum release was not caused by a LUST regulated by the Utah Underground Storage Tank Act, Utah Code Ann., 19-6-400, the DERR will refer the release to the appropriate regulatory agency, and notify the owner/operator. The RBCA process may not be applicable in cases excluded from Utah Code Ann., 19-6-400.

If the submitted data are sufficient for determining that contamination has resulted from a UST as defined in Utah Code Ann., 19-6-400, then proceed to Step 4.

Step 4: Are MCLs or Other Standards Exceeded?

Analytical data collected at the site are evaluated to determine if MCLs for groundwater or other applicable standards for soil (for example, UBERR, 1990) are exceeded or unknown. If those levels are not exceeded at the source or at any receptor, no further actions are required (Step 14). If the MCLs or other applicable standards are exceeded or unknown, go to Step 5 where the DERR will issue the Tier 1 information packet.

Step 5: DERR Issues Owner/Operator Tier 1 Information Packet or Data Requirements

The DERR project manager assigned to the site sends the owner/operator of the LUST site a Tier 1 information packet outlining the information needed to complete the Tier 1 Worksheet. The owner/operator is required to provide the site assessment information needed to complete the Tier 1 evaluation. The packet contains the Tier 1 Worksheet , a PST Fund Application, and other information to assist the owner in completing the Tier 1 screening process. Proceed to Step 6.

Step 6: Are Data or Worksheet Sufficient to Complete a Tier 1 Evaluation?

The owner/operator is required to submit either a completed Tier 1 Worksheet or sufficient data to enable the DERR project manager to complete the worksheet. Data submitted by the owner/operator will be evaluated by the DERR project manager to determine if the information is complete and sufficient for classifying sites and for conducting the Tier 1 screening process. The process includes identifying receptors and comparing contaminant concentrations at the source to Tier 1 screening levels. If the owner/operator submits incomplete or insufficient data to classify the site or complete the Tier 1 screening process, go back to Step 5 and the DERR will issue a letter to the owner/operator identifying what data are required, otherwise proceed to Step 7.

Step 7: Site Classification

Following a Release Report, the DERR classifies the site according to the degree of contamination and potential to impact receptors (Appendix A). The site-specific data submitted by the owner/operator are used for determining the level of environmental priority and guiding the owner/operator to initiating the appropriate necessary response actions. Site classification data and information can be supplied in the form of the Release Report, Closure Notice, Closure Inspection Report, Tier 1 Worksheet, and other reports. The DERR project manager evaluates current available site data and information and uses guidance outlined in Appendix A to determine the most representative site classification scenario and appropriate owner/operator-implemented response actions. An emergency condition, or Classification 1, is assigned if a direct and immediate threat exists. Limited or insufficient data will result in a protective classification and aggressive response requirements (Class

2.0). The site classification is dynamic and is re-evaluated as site conditions change and as additional information is obtained. Proceed to Step 8.

Step 8: DERR Project Manager Completes or Evaluates the Tier 1 Worksheet.

If the owner/operator chooses to submit a completed worksheet then the DERR project manager will evaluate the worksheet and make recommendations regarding further actions if necessary. The owner may choose to submit only the data and the DERR project manager will then complete the worksheet.

Completing the Tier 1 Worksheet

The Tier 1 Worksheet provides a short but comprehensive format to simplify and expedite the process for reporting and evaluating the nature of the release, exposure pathways, and potential impact to receptors to determine if the release poses a threat to human health or the environment. The Worksheet must be completed in its entirety by marking the applicable spaces provided. ***Incomplete or deficient information may result in processing delays.*** The Worksheet may be completed by the owner/operator, owner's representative, or the DERR by entering all pertinent information that is supplied by the owner/operator, or owner's representative. **The owner/operator completes only the unshaded portions of the worksheet; the DERR project manager will complete the shaded portions.** The information necessary for the Worksheet can be obtained from the Release Report, Closure Notice, Closure Plan, Closure Inspection Report, other reports, sampling data, historical information, and detailed site maps.

If at any time the DERR's evaluation of the Worksheet reveals that insufficient information is supplied or that exposure pathways are complete and receptors are at risk, additional site-specific information must be obtained (perform a Tier 2 subsurface investigation), and appropriate response actions must be taken in accordance with the Site Classification (Appendix A).

8.1: Facility Information

The owner/operator provides this portion of the Worksheet information by providing the facility name, location, and the owner's name, address, and phone number. The DERR completes the shaded portion of the form by providing the facility identification number, release identification number, notification date and reporting party, the DERR project manager, and name of person completing the Worksheet.

8.2: Site Assessment Information

a. **Site Classification**

Indicate the Site Classification level for the facility at the time the Worksheet is

completed. Extra space is provided for additional information such as impacts to human health and the environment and the response actions required for reducing risks. See Appendix A for a description of the Site Classification levels.

b. **Contaminant Source Information**

The product type released at the site, such as gasoline, diesel, waste oil, or unknown substance, must be identified in the spaces provided. If known, provide the amount of product released in the spaces provided. Mark the applicable spaces provided for the portion of the UST system that caused the release (if known), such as the tank, the piping, the dispenser, and/or overfills/spills. Unknown product types usually require sampling for additional constituents and the need for historical information (UAC R311-205(c).

The source of contamination must be removed in accordance with Utah's Cleanup Policy (UAC R311-211). Mark the applicable spaces provided to indicate that contaminant sources that caused the release have been removed. The source of the petroleum contamination may be the tank basin, product piping runs, dispensers, free product, or contaminated soil that leaches excessive contaminant concentrations to groundwater or other receptors.

c. **Land Use Information**

Land use of the site and the surrounding neighborhood must be identified in order to determine the potential for exposure to contamination and to ensure adequate protection of human health and the environment. Land uses considered in Tier 1 evaluations include residential, commercial, and industrial. Land use information can be supplied in the Closure Plan, Closure Notice, other reports, and site maps.

The current land use at the site is considered residential if a residence is located on the site property. The surrounding neighborhood is considered residential if a residence is located on any property adjacent to the site. Commercial land use is defined as land used for the sale of pre-made products. Industrial land use is that devoted to manufacture of commercial goods.

d. **Soil Information**

The Worksheet provides spaces for identifying the soil type and depth at which contaminated soil occurs. Soil samples must be collected in accordance with UAC R-311-205 (Site Assessment Protocol), which includes proper sample collection by a Utah Certified Groundwater and Soil Sampler, and sample analysis by a Utah Certified Laboratory of all media affected by the release (groundwater, subsurface soil, etc.). Proper sample collection and supporting documentation are essential for the Tier 1 site assessment. Improper sample collection and analysis may delay or impede completion of the Tier 1 evaluation.

The contaminated soil type is identified using the Unified Soil Classification method. Other observations concerning the soil type and characteristics may be explained here or in the "Supplemental Information" category.

e. **Groundwater Information**

Groundwater is a valuable and protected natural resource in the State of Utah and a large percentage of LUST sites in Utah impact groundwater. Because groundwater is the primary contaminant transport mechanism there is subsequently a greater potential for contamination to be transported off-site to other receptors.

When completing the Worksheet mark the appropriate space if groundwater is or was present in the excavation and indicate the thickness of free product, if present. Also, indicate whether or not the groundwater is impacted to any level of contamination. Identify the depth to groundwater and the approximate groundwater flow direction. Knowledge of the approximate groundwater flow direction will help determine the probability of a petroleum release adversely impacting nearby receptors. Groundwater flow direction can be estimated from the slope direction of the local topography. This can be obtained from a topographic map.

Groundwater information can be determined from site-specific or nearby site data, such as monitoring wells, water supply wells, open excavations and test pits, and the slope direction of local topography. Other informational resources include the DERR Geographic Information System, local health departments, the DEQ district engineer, and local and regional groundwater studies.

f. **Distance from Source to Nearest Potential Receptors**

Enter the distance, in feet, to all receptors in the spaces provided. The distance to receptors is compared to the critical distances at which receptors may be threatened by the contamination.

Receptors that must be identified within a ***30-foot radius*** of the contaminant source area ***and*** plotted on the Facility Site Map (see 8.3) include ***subsurface utility corridors*** (water lines, sewer lines, etc), ***buildings***, and the ***property lines***. The owner/operator can obtain much of this information from a visual inspection of the site. The shaded "Other Receptor Information" section of the worksheet will be completed by the DERR project manager. The DERR project manager will identify receptors within a ***500-foot radius*** of the source area which include ***water wells*** (municipal or residential) and ***surface water*** (rivers, lakes, streams, wetlands, irrigation or other ditches). The DERR project manager will obtain the water well and surface water maps and data sheets from the Utah Department of Natural Resources, Division of Water Rights (DNR). The DERR project manager will also use topographic maps to determine distance to nearest surface water. If the

owners/operators choose to obtain this information from the DNR and topographic maps then all data sheets and maps must be attached to the worksheet. ***All submitted maps and data sheets must show the location of the facility***.

8.3 Facility Site Map

A site map of the facility must be included with the Worksheet. The map must show a north arrow and be either an appropriate scale that shows the locations of the following features or measured distances from the contamination to these features: current and/or former UST systems (tanks, piping, dispensers, other), buildings or other structures (identify residential or commercial structures), underground utility lines, all property boundaries, excavations, soil stockpiles, sample locations, monitoring wells, and any other pertinent features that will help speed up the Tier 1 screening process. A facility site map from the closure plan may be attached to the worksheet if it provides the features and distances identified above.

8.4 Supplemental Information

The DERR project manager evaluates additional information provided by the owner/operator and enters that information on page 2 of the Worksheet. The supplemental information may influence the recommended Tier 1 actions and may contain elements of a Tier 2 evaluation.

Supplemental information may aid in expediting the Tier 1 evaluation process and may include information concerning the extent and degree of contamination, additional soil and groundwater information, exposure pathway and receptor information, additional Site Classification information, amount of contaminated media remaining, rate of release, or other site-specific data that are used for calculating screening levels and reducing risk to potential receptors.

8.5: Tier 1 Screening Level Evaluation

The owner/operator provides copies of the laboratory analytical data and the DERR project manager compares those data to the screening levels by entering the highest observed concentrations in the spaces provided for groundwater and for soil. The owner/operator may fill in the spaces for highest observed levels but analytical data must also be attached to the Worksheet. The DERR project manager compares the highest observed concentrations to the corresponding screening levels to determine if any levels are exceeded.

8.6: Recommended Tier 1 Actions

The DERR project manager completes this shaded portion of the Worksheet by checking the appropriate recommendation to document whether screening levels have or have not been exceeded and whether receptors exist within the critical distances as described in section f above. The project manager then issues the owner/operator a letter indicating the results of the Tier 1 screening evaluation. The letter may indicate no further action required or the need to collect additional data and perform a Tier 2 subsurface investigation, a Tier 2 risk assessment and/or cleanup. Proceed to Step 9.

Step 9 Are Tier 1 Screening Levels Exceeded at the Source?

Tier 1 screening levels represent contaminant concentrations in soil and groundwater at the source that are expected to be protective as long as there are no receptors within the critical distances described above in Step 8.2.f. If all contaminant concentrations are less than the applicable screening levels proceed to Step 10 and review the Site Assessment Information portion of the Worksheet for distance to receptors (Step 8.2.f).

If any constituent concentration exceeds the screening level, go directly to Step 11.

Step 10: Are Receptors within the Critical Distances?

If distances to property lines, utility lines, and buildings are greater than 30 feet, ***and*** distances to water wells and surface water bodies are greater than 500 feet, as described in 8.2.f, go to Step 14 (No Further Action). If any of the referenced receptors are within the prescribed distances, go to Step 12 and perform cleanup or a Tier 2 investigation, Tier 2 risk assessment, and/or cleanup.

Step 11: DERR Issues Owner/Operator Tier 2 Guide for Risk Assessment and Cleanup

The Tier 2 guide describes the procedures to perform a Tier 2 risk assessment. A Tier 2 risk assessment can only be accomplished by gathering site specific information through a subsurface investigation. The Tier 2 guide aids owners/operators in determining cleanup levels that are achievable, cost effective as well as protective of human health and the environment. Proceed to Step 12.

Step 12: Owner Performs Tier 2 Risk Assessment or Cleanup

If source concentrations exceed the screening level for any constituent, ***or*** if evaluation of the Worksheet indicates that receptors are at risk or threatened, the Executive Secretary (UST) may send the owner/operator a Tier 2 guidance letter. The Tier 2 guide will indicate that either a subsurface investigation must be performed(to define extent and degree of contamination), additional site-specific information for a Tier 2 risk assessment be submitted, and/or cleanup (corrective action) be undertaken.

When Tier 1 screening levels are exceeded the DERR sends the owner/operator a Tier 2 letter. The owner/operator will select one of the following options:

a. Develop and implement a corrective action plan (CAP) to achieve applicable contaminant levels and ensure that exposure pathways are not complete and that receptors are not at risk. The CAP may include source removal, compliance monitoring, active remediation and/or institutional controls. Additional site investigation may be necessary in order to develop a CAP that is protective of human health and the environment.

b. Collect additional site-specific assessment information in accordance with the Tier 2 RBCA process. This option is typically based on comparing the cost of achieving Tier 1 screening levels with the cost of performing a Tier 2 evaluation, assuming that the site-specific Tier 2 cleanup levels will be above the actual site contaminant concentrations. It should be noted that both Tier 1 screening levels and Tier 2 cleanup levels are based upon achieving similar levels of protection of human health and the environment. However, the Tier 1 conservative assumptions are replaced with site-specific information, during the Tier 2 evaluation.

Following this step, proceed to Step 13.

Step 13: Is Risk Assessment Acceptable or does Cleanup Achieve Protection of Receptors?

If in the Tier 2 Risk Assessment the site specific conditions indicate that contaminant concentrations present at the site do not pose a threat to human health or the environment then monitoring or no further action may be recommended. If cleanup is undertaken the DERR project manager tracks the progress made in cleaning up the contamination to concentrations that ensure current and future protection of human health and the environment. If cleanup to protective levels is not achieved, go back to Step 12. When cleanup is achieved and no further monitoring is necessary, go to step 14. The Tier 2 Guidance describes this process in further detail.

Step 14: No Further Action

If the Tier 1 Screening Levels are not exceeded at the source and there are no receptors within the prescribed distances, the Executive Secretary (UST) of the Utah Solid and Hazardous Waste Control Board may concur with the recommendation for no further action and issue a "close-out letter" to the owner/operator.

APPENDIX A

RBCA SITE CLASSIFICATION

II. Purpose and Scope

The purpose of site classification is to ensure that when current or potential exposure pathways are complete and/or when receptors are subsequently at risk, the MCLs or other applicable standards are met in accordance with Utah's Cleanup Rules (UAC R311-211). Screening levels at any Tier are not intended to replace MCLs under any Tier, and MCLs still apply under certain site classification scenarios.

Site classification assists to determine the immediacy and degree of potential hazards to human health and the environment, and determine appropriate response actions (see Table A.1). Site classification also aids the DERR in prioritizing sites according to the current or potential risk to receptors. By evaluating the site-specific data provided by the Tier 1 Worksheet, site classification allows a case-by-case evaluation of current and potential hazards to assure protection of all receptors to the maximum extent possible.

LUST site classification provides the owner/operator, DERR project manager, the owner's representative or consultant, and the public with the opportunity to identify, clarify, and understand the current and projected degree of hazards to human health and the environment associated with contamination at a site. Site classification is based on the most recent data and reflects the current site conditions. Since the risks posed by contamination at any given site are expected to change as more is learned about a site, a site is re-classified as additional information is received.

III. Process

The process for classifying sites and determining appropriate response actions is flow-charted in Figures A.1 and A.2. Site classification is dynamic and changes as current information becomes available. Tier 1 evaluations may not contain all of the information shown in Table A.1. During the entire project management process, a given site will be classified according to the potential risk to receptors. The various response actions identified in Table A.1 correspond to each classification and are implemented in order of priority and urgency to eliminate any potential impact to receptors.

The response actions are called "potential" because all possible response actions may not be listed in Table A.1. In all cases, the source must be removed and local authorities and potentially affected parties must be notified.

A. Data Collection

Site-specific data necessary for site classification are supplied by the owner/operator or owner's representative, in the form of the Closure Notice, Release Report, Tier 1 Worksheet, other reports, sampling data, and historical information. Additional information for site classification may be provided by the DERR and Closure Inspection Report, local health departments, and fire departments. Other concerned parties may assist in classifying a site, such as neighbors to a LUST site that detect vapors in their building (example of Class 1.1), or a utility company that encounters petroleum during a routine check of a subsurface utility (example of Class 1.2).

Site-specific data for site classification include contaminant concentrations and extent, distance to receptors (water wells, surface water bodies, utility lines, buildings), and baseline hydrologic data such as groundwater flow direction and velocity. Most of that information is routinely gathered and supplied by the owner/operator and is reported in the Tier 1 Worksheet.

B. Site Classification Scenarios and Potential Response Actions

The classification scenario most representative of actual site conditions is assigned, beginning with Classification 1 (sites with an immediate threat to human health and the environment), while Classification 4 sites represent the least threat, and the intermediate classifications represent varying degrees of potential threats. A site is considered to be a Classification 2.0 when a release is first reported, unless emergency conditions exist (Classification 1). This classification represents a conservative assumption that all sites represent at least a short-term threat to human health and the environment. As soon as site-specific information is received, the classification will be altered to reflect more or less serious threats.

Each classification scenario detailed in Table A.1 is associated with a recommended response action that must be implemented in order to eliminate or minimize any current or potential immediate threats to human health and environment, and ensure that resources are focussed on higher priority sites. Site classification therefore serves to prioritize sites and hence implies a continuing management policy that constantly appraises the threat to human health and the environment posed by contamination at a site.

The classification system is designed to provide an indication of the actual current conditions at the site. As more site information is obtained, the accuracy of the classification to reflect actual site conditions is greater. The owner/operator and other responsible parties will be promptly notified of any re-classification that would change corrective action at the site or indicate risk to receptors.

TABLE A.1

RBCA SITE CLASSIFICATION

(modified from ASTM, 1994)

SITE CLASSIFICATION SCENARIO	*POTENTIAL INITIAL RESPONSE ACTIONS*
Classification 1: Immediate threat to human health, safety, or sensitive environmental receptors	***Remove Source; Notify Local and Other Authorities, Property Owners, and Potentially Affected Parties, and; Evaluate the Need to Implement the Following:***
1.1 **Vapor Accumulation in Structures:** Explosive levels, or concentrations of vapors that could cause health effects, are present in a residence or other building.	*Evacuate occupants, begin abatement measures, such as subsurface ventilation, or building pressurization or free-product removal.*
1.2 **Vapor Accumulation in Utility Lines:** Explosive levels of vapors are present in subsurface utility system(s), but no buildings or residences are impacted.	*Evacuate immediate vicinity, begin abatement measures such as ventilation.*
1.3 **Free Product Release:** Free product is present in significant quantities at ground surface, on surface water bodies, in utilities other than water supply lines, or in surface water runoff.	*Prevent further free product migration by appropriate containment measures, institute free-product recovery, restrict area access.*
1.4 **Public Water Supply Impact:** An active public water supply well, public water supply line, or public water surface intake is impacted or immediately threatened.	*Notify user(s), provide alternate water supply, hydraulically control contaminated water, and treat water at point-of-use.*
1.5 **High Ambient Vapor Concentrations:** Ambient vapor/particulate concentrations exceed concentrations of concern from an acute exposure or safety viewpoint.	*Install a vapor barrier, (capping, foams, etc.), remove the source, or restrict access to affected area.*
1.6 **Ecological Impact:** A sensitive environmental habitat, or sensitive resources (sport fish, economically important species, threatened and endangered species, etc.) Is impacted and adversely affected.	*Minimize extent of impact by containment measures, and implement habitat management to minimize exposures.*

SITE CLASSIFICATION SCENARIO	*POTENTIAL INITIAL RESPONSE ACTIONS*
Classification 2: Short-term threat, (0-2 years), to human health, safety, or sensitive environmental receptors	***Remove Source; Notify Local and Other Authorities, Property Owners, and Potentially Affected Parties, and; Evaluate the Need to Implement the Following:***
2.1 **Potential Vapor Accumulation:** There is a potential for explosive vapor levels or concentrations of vapors that could cause acute health effects by accumulating in a residence or other buildings.	*Assess the potential for vapor migration (through monitoring/modeling) and remove source, if necessary, or install a vapor migration barrier.*
2.2 **Free Product on Groundwater:** Free product of any measurable thickness on or in groundwater.	*Prevent free-product migration by appropriate containment measures. Begin free product removal immediately.*
2.3 **Offsite Migration:** Groundwater is impacted with the potential for migrating offsite.	*Define extent and degree of contamination. Institute groundwater monitoring.*
2.4 **Contaminated Soil in Proximity to Receptors:** Shallow contaminated soils are exposed and open to public access, and dwellings, parks, playgrounds, day-care centers, schools, or similar use facilities are within 500 feet (152 meters) of the soils.	*Remove soils, cover area, or restrict access.*
2.5 **Water Supply Well Impacted:** A water supply well is impacted or immediately threatened.	*Notify owner/user. Evaluate need for point-of-use water treatment, hydraulic control, or alternate water supply.*
2.6 **Potential Water Supply Well Impact:** Groundwater is impacted, and a public or domestic water supply well producing from the affected groundwater is located within two years projected groundwater travel distance down-gradient of the known extent of contamination.	*Institute monitoring. Evaluate if natural attenuation is sufficient, or if hydraulic control is needed.*
2.7 **Potential Water Supply Well Impact:** Groundwater is impacted, and a public or domestic water supply well producing from a different interval is within the known area of contamination.	*Monitor groundwater well quality and determine need for prevention of vertical migration to the supply well.*
2.8 **Plume Discharge to Surface Water:** Impacted surface water, storm water, or groundwater discharges within 500 ft of a sensitive habitat, or surface water body used for human drinking water or contact recreation.	*Begin containment measures. Restrict access to areas near discharge. Evaluate magnitude and impact to discharge area.*

SITE CLASSIFICATION SCENARIO	*POTENTIAL INITIAL RESPONSE ACTIONS*
Classification 3: Long-Term Threat, (>2 years), to Human Health, Safety, or Sensitive Environmental Receptors	***Remove Source; Notify Local and Other Authorities, Property Owners, and Potentially Affected Parties, and; Evaluate the Need to Implement the Following:***
3.1 **Potential Leachate Migration:** Subsurface soils (> 3 ft bls) are impacted, and depth from impacted soils to the first groundwater is less than 50 ft.	*Define and monitor groundwater and determine the potential for future contaminant migration to the groundwater.*
3.2 **Potential Water Well Producing from Impacted Interval:** Groundwater is impacted, and water supply wells producing from the impacted interval are located more than two years projected groundwater travel distance down gradient of the known extent of contamination.	*Define and monitor the dissolved plume and evaluate the potential for future contaminant migration for natural attenuation and need for hydraulic control.*
3.3 **Potential Water Well not Producing from Impacted Interval:** Groundwater is impacted and water supply wells that do not produce from the impacted interval are located within the area of known contamination.	*Define and monitor the dissolved plume, notify the user, determine the potential for vertical migration, and determine if any impact is likely.*
3.4 **Potential Surface Water or Ecological Impact:** Impacted surface water, storm water, or ground water discharges within 1500 ft of a sensitive habitat, or surface water body used for human drinking water or contact recreation.	*Investigate current impact on sensitive habitat or surface water body, restrict access to area of discharge and evaluate the need for containment/control measures.*
3.5 **Contaminated Soil Exposed:** Shallow contaminated soils are exposed and open to public access, and dwellings, parks, playgrounds, day-care centers, schools, or similar use facilities are more than 500 feet (152.4 meters) from the soils.	*Restrict access to affected soils.*

SITE CLASSIFICATION SCENARIO	*POTENTIAL INITIAL RESPONSE ACTIONS*
Classification 4: No Demonstrable Long-Term Threat to Human Health, Safety, or Sensitive Environmental Receptors	***Remove Source; Notify Local and Other Authorities, Property Owners, and Potentially Affected Parties, and; Evaluate the Need to Implement the Following:***
4.1 **Impact to Groundwater:** Groundwater is impacted but not used locally.	*Monitor groundwater and evaluate effect of natural attenuation on dissolved plume migration.*
4.2 **Low Potential for Leachate Migration:** Impacted soils located more than 3 ft BGS and greater than 50 above the nearest groundwater.	*Monitor groundwater and evaluate effect of natural attenuation on leachate migration.*
4.3 **Low Potential for Water Supply Well Impact:** Groundwater is impacted and wells are located down-gradient outside the known extent of contamination, and they produce from a non-impacted zone.	*Monitor groundwater and evaluate effect of natural attenuation on dissolved plume migration.*

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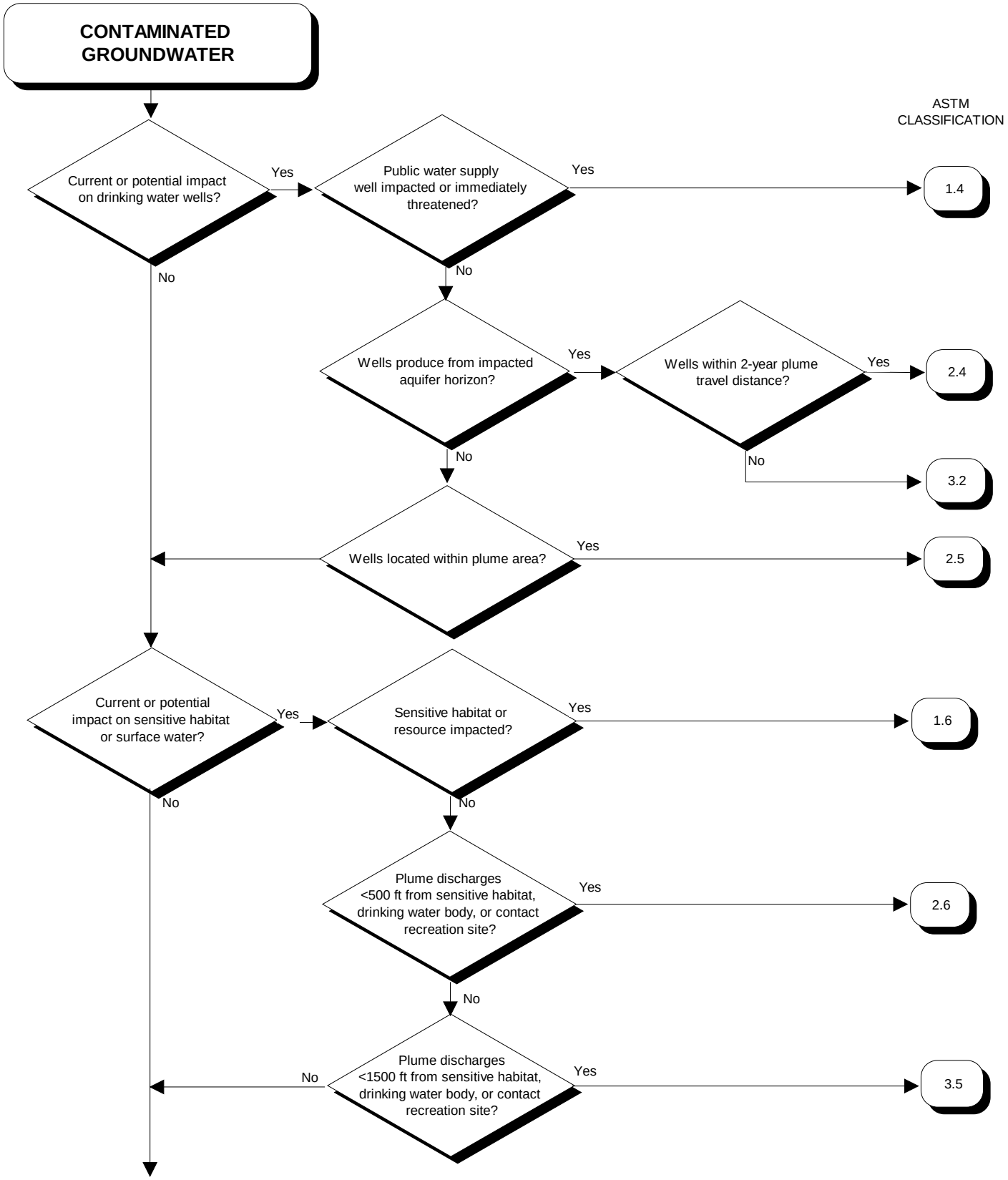
FIGURE A.1---ASTM SITE CLASSIFICATION SYSTEM
CONTAMINATED GROUNDWATER EVALUATION



(Cont. Next Page)

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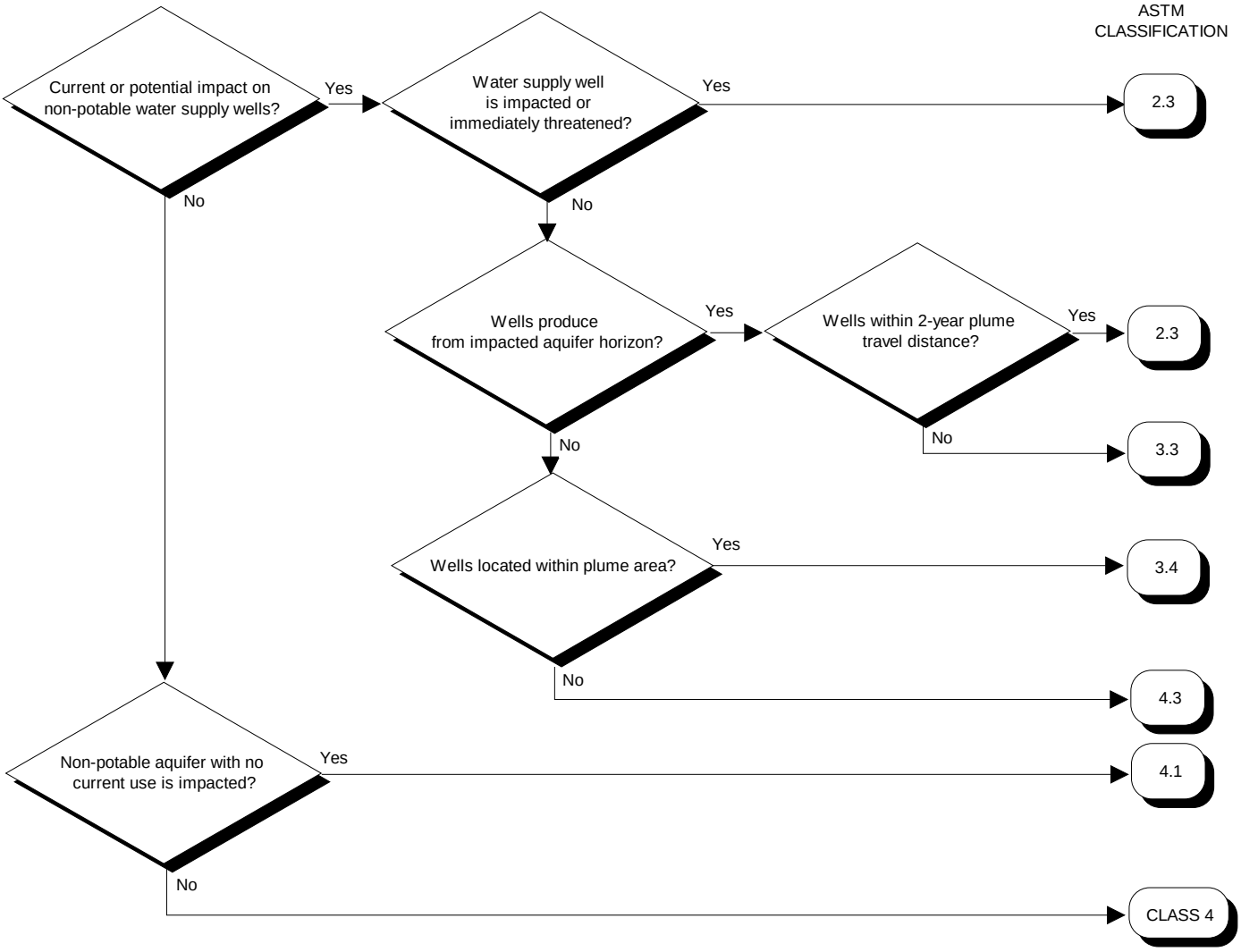
FIGURE A.1 CONTINUED---ASTM SITE CLASSIFICATION SYSTEM

CONTAMINATED GROUNDWATER EVALUATION (CONT.)



Instructions:

1) To determine ASTM Site Classification, evaluate available information on site soils, vapors, groundwater, surface water, and miscellaneous impacts using the corresponding flowcharts.

2) Compare numerical values from individual flowcharts to identify the critical site classifications (ie - lowest values).

3) See Table A.1 for ASTM Classification scenarios and initial response actions corresponding to the classification numbers listed above.

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FIGURE A.2---ASTM SITE CLASSIFICATION SYSTEM
CONTAMINATED VAPOR AND SOIL EVALUATION

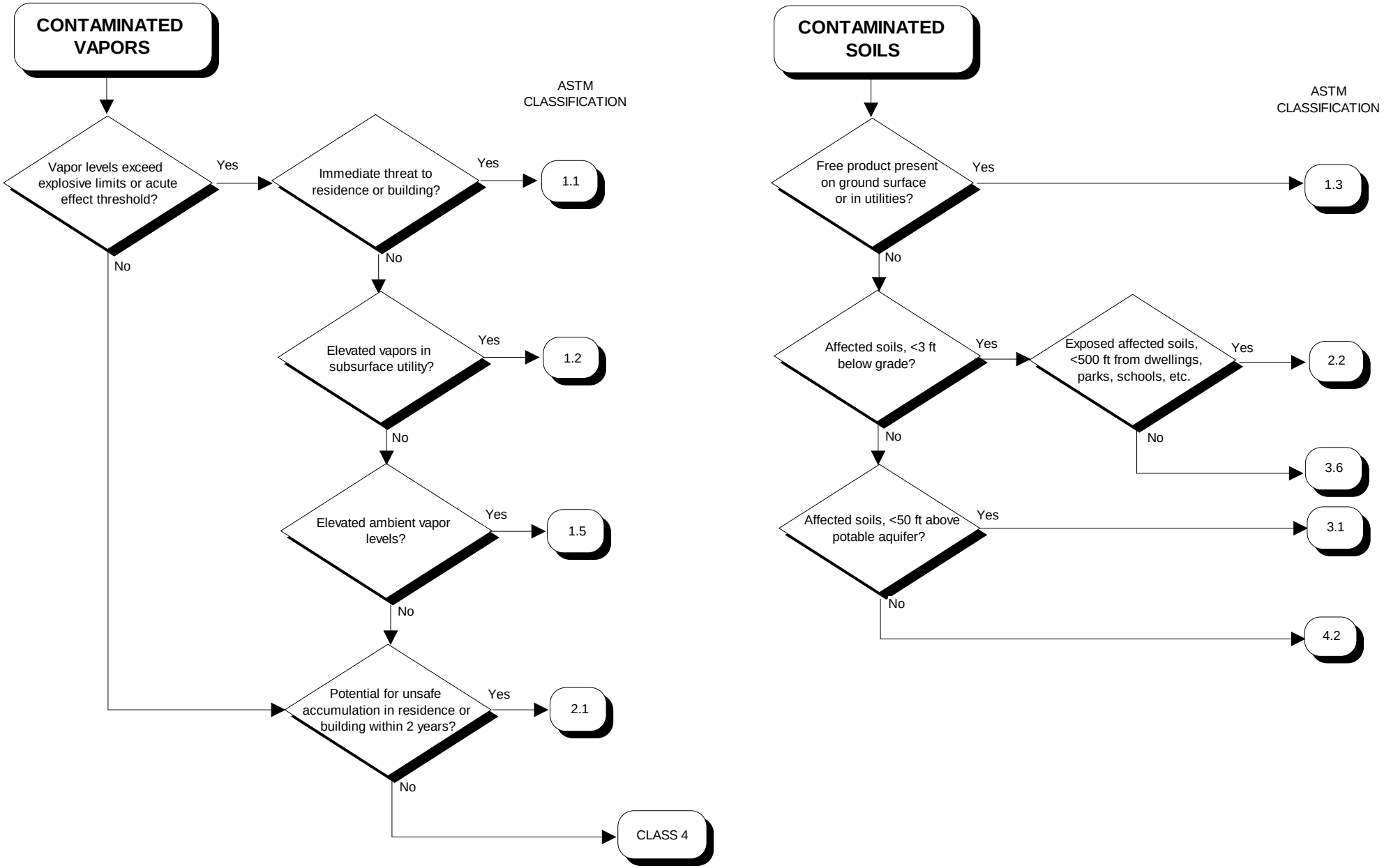

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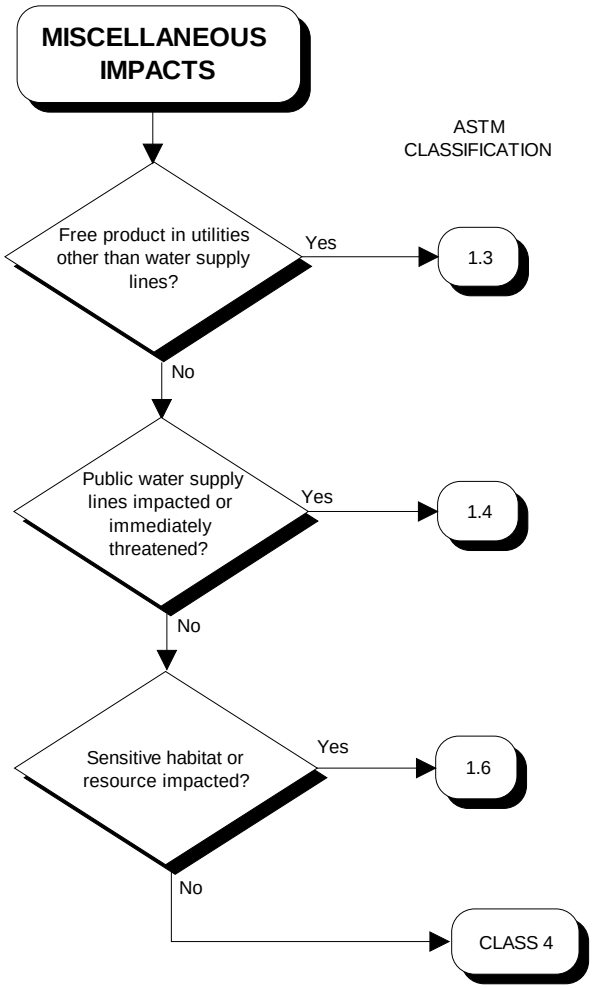
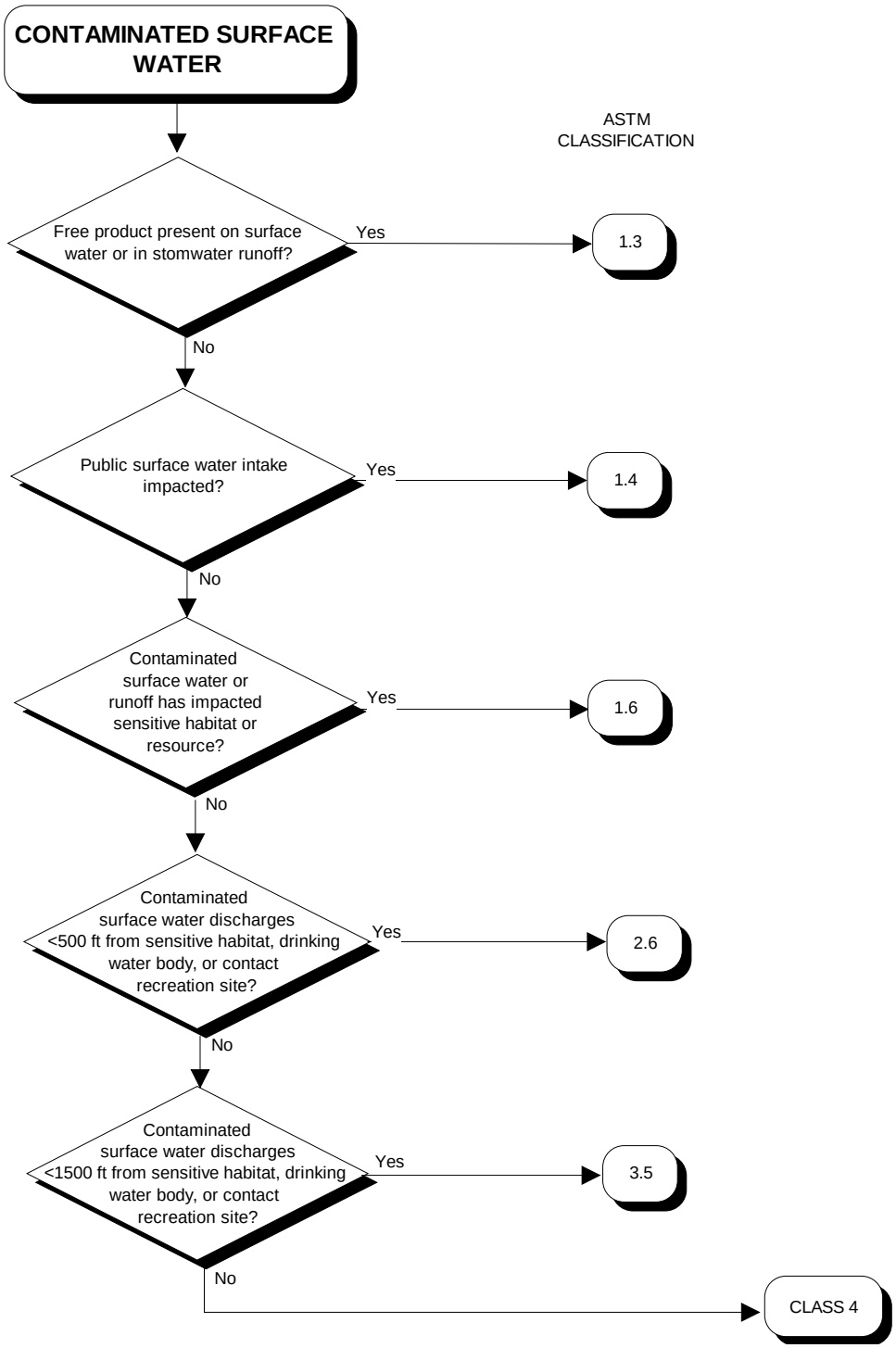
FIGURE A.2 CONTINUED---CONTAMINATED SURFACE WATER AND MISCELLANEOUS IMPACTS





Instructions:

1) To determine ASTM Site Classification, evaluate available information on site soils, vapors, groundwater, surface water, and miscellaneous impacts using the corresponding flowcharts.

2) Compare numerical values from individual flowcharts to identify the critical site classifications (ie - lowest values).

3) See Table A.1 for Classification scenarios and initial response actions corresponding to the classification numbers listed above.

APPENDIX B

TIER 1 SCREENING LEVELS FOR PETROLEUM-CONTAMINATED SITES

I. INTRODUCTION

The Utah Department of Environmental Quality (UDEQ) Leaking Underground Storage Tank (LUST) Program has developed Tier 1 risk-based screening levels (RBSLs) and non-risk-based screening levels (NRBSLs) for petroleum-contaminated soil and groundwater. The RBSLs were developed from the exposure equations found in American Society for Testing and Materials (ASTM) Emergency Standard ES-38-94 (ASTM, 1994) which were developed into a comprehensive electronic spreadsheet system entitled "RBCA Tier 1 and Tier 2 RBCA Spreadsheet System" (Groundwater Services, Inc., 1995). The spreadsheet calculates numerically-based screening levels of contamination at the source. The NRBSLs were developed using some of the same methods used for calculating the RBSLs.

Options in the RBCA Spreadsheet System allow users to vary the ASTM default values to be more representative of the geographic- or site-specific climatologic, geologic, and hydrologic characteristics. The ASTM default values reflect a geographical setting different from Utah's values; one of high rainfall and infiltration, highly transmissive aquifer sediment, and high groundwater velocities. Some of those default values have been changed to reflect the general characteristics of Utah's intermontane basins.

Screening levels for total petroleum hydrocarbons (TPH), total recoverable petroleum hydrocarbons (TRPH), and oil and grease are based largely on risk-management decisions using both qualitative and quantitative criteria, including aesthetic impacts, fate and transport modeling of indicator chemicals in TPH, and other UDEQ/LUST guidelines (UBERR, 1990).

Utah-specific parameter values are compared to ASTM default values in Table B.1. Metric and U.S. units of measurement are also provided. Other attachments in this Appendix B include chemical-specific properties and toxicity values (Table B.2), and the equations for the Tier 1 exposure pathways (Table B.3).

The following sections describe the rationale that is used to depart from standard ASTM values and use Utah-specific values for the development of Tier 1 screening levels. (***Note: Bold italics indicate changes from ASTM default values***).

II. EXCESS RISK

Utah's Cleanup Policy requires that receptors be protected to MCLs or a 10^{-6} TER equivalent level. For Tier 1 screening purposes, however, the UDEQ has determined that contaminant levels representing a TER of 1 X 10^{-4} at the source area generally attenuate to a 10^{-6} level within 30 feet

of the source area.

The only compound considered in petroleum contamination that has known carcinogenic potential is benzene. Thus, the screening levels are based on the following factors:

A. Conservative assumptions are built in at the lowest level of the RBCA process. Specifically, the parameters used for risk evaluation are conservative conditions for exposure rates and duration for the most sensitive exposure scenario, residential land use settings.

B. Screening levels calculated for a 10^{-6} target risk are extremely low, often below accurate laboratory detection limits for the BTEXN constituents and the UBERR (1990) recommended cleanup levels (RCLs). Thus, a 10^{-6} target risk at the source area for Tier 1 screening levels at the source area may not be appropriate for screening purposes at the majority of LUST sites.

III. CHEMICAL-SPECIFIC PROPERTIES

A. **Benzene, Toluene, Ethylbenzene, Xylenes, and Naphthalene (BTEXN)**: Specific chemical properties and toxicity values for the constituents of concern, BTEXN, are shown in Table B.2. Those properties and values can also be found in ASTM (1994) and Knox, et.al. (1993). Cancer slope factor values are shown for benzene and reference dose values are shown for toluene, ethylbenzene, xylenes, and naphthalene (EPA, 1995).

The RBSL for naphthalene is lower than the benzene RBSL because naphthalene is a systemic toxicant for which a hazard quotient of 1 is used for calculating the RBSL, whereas benzene, a carcinogen, is based on an excess risk limit of 10^{-4}.

B. **Total Petroleum Hydrocarbons (TPH)**: Risk-based screening levels for TPH are not derived from the equations in Table B.3 because there are currently no cancer slope factor or reference dose values for TPH. However, TPH does have toxic characteristics and, when released into the environment, warrants further evaluation by non-risk-based methods. The TPH screening levels were derived from the methods described below.

1. ***General Nature of TPH***: The behavior, fate, and transport of TPH in the environment are uncertain and unpredictable due to the complex composition of petroleum fuels. Petroleum fuels are comprised of up to 500 chemical compounds (API, 1989) which are primarily hydrocarbons with total number of carbon atoms between 3 and 24 (C_3 to C_{24}). The majority of compounds in gasoline range from C_3 to C_{13} (California, 1989; Nyer and Skladany, 1989; Johnson, et al., 1990; Kreamer and Stetzenbach,

Table B.1
Input Parameter Data for Tier 1 RBCA Evaluations*

			ASTM Default Input Values		Utah-Specific Input Values	
Parameter	**Definition and Units**	**Input Units**	**Residential**	**U.S. Units**	**Residential**	**U.S. Units**
A	Contaminated area	cm^2	2.2×10^6	2420 ft^2	2.2×10^6	2420 ft^2
AT_c*	Averaging Time for carcinogen	years	70	years	70	years
AT_{nc}*	Averaging Time for non-carcinogens	years	30	years	30	years
BW*	Body weight, adults	kg	70	154 lbs	70	154 lbs
d	Thickness of surficial soil	cm	100	3.28 ft	100	3.28 ft
ED*	Exposure duration, adults	years	30	years	30	years
EF*	Exposure frequency	days/ year	350	years	350	years
H*	Henry's Law coefficient	dim., cm^3-H_2O)/ (cm^3-air)	chemical-specific see Table B.2			
h_{cap}	Thickness of capillary fringe	cm	5	1.97 in	***91***	***36 in, 3 ft***
h_v	Thickness of vadose zone	cm	300	118 in, 9.8 ft	***120***	***48 in,4 ft***
I*	Infiltration rate of water through soil	cm/yr	30	11.8 in/yr	***15***	***5.9 in/yr***
IR_{water}*	Ingestion rate, daily	liters/ day	2	0.53 gal	2	0.53 gal
IR_{air}	Inhalation rate, daily outdoor	m^3/day	20	706 ft^3 353 ft^3	20	706 ft^3 353 ft^3
Koc	Adsorption coefficient	mL/g	Chemical-specific (see Table B.2)			
L_s	Depth to contaminated soil	cm	100	3.28 ft	***180***	***6 ft***
L_{GW}	Depth to groundwater	cm	300	9.8 ft	***210***	***84 in, 7 ft***
LF_{s-w}*	Leaching factor of soil to groundwater	mg/L-H_2O)/ (mg/kg-soil)	0.315 for all Tier 1; calculated from Equation 3, Table B.3			

* Parameters used in equations in Table B.3. All other parameters are those used in the RBCA spreadsheet.

Table B.1, continued

Parameter	Definition and Units	Input Units	ASTM Default Values		Utah-Specific Values	
			Residential	U.S. Units	Residential	U.S. Units
$RBSL_{water}$*	Risk-based screening level for water to be ingested	mg/L-H_2O	calculated from Groundwater Services Inc., 1994, RBCA spreadsheet system or Table B.3 Equations			
$RBSL_{soil}$*	Risk-based screening level for subsurface soil leaching to GW	mg/kg-soil				
RfD_o*	Reference Dose, oral	mg/kg-day	chemical-specific see Table B.3			
S	Solubility (aqueous)	mg/L	chemical-specific see Table B.3			
SF_o*	Cancer slope factor, oral	$(mg/kg-day)^{-1}$	chemical-specific see Table B.3			
SF_i	Cancer slope factor ($(mg/kg-day)^{-1}$), inhalation	$(mg/kg-day)^{-1}$	chemical-specific see Table B.3			
THQ*	Target Hazard Quotient	unitless	1	unitless	1.0	unitless
TOC	Total organic carbon	per cent	1.0 (0.01)	per cent	***0.5 (0.005)***	***per cent***
TER*	Target Excess Lifetime Cancer Risk	unitless	10^{-6} or other	unitless	***10^{-6} at source***	***unitless***
U_{darcy}*	Groundwater Darcy velocity (k x i)	cm/yr	2500	82 ft/yr	***1100***	***36***
W*	Width of contaminated source area parallel to GW flow or wind direction	cm	1500	50 ft	1500	50 ft
ρ_b*	Bulk density of soil	g/cm^3	1.7			
δ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil	0.038			
δ_T	Total soil porosity	cm^3/cm^3-soil	0.38			
δ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-H_2O/cm^3-soil	0.342			
δ_{ws}*	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil	0.12			
δ_{as}*	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil	0.26			
δ_{gw}*	Groundwater mixing zone thickness	cm	200	6.6 ft	200	6.6 ft

TABLE B.2
Chemical-Specific Properties and Toxicity Values

Chemical	Molecular Weight (g/mol)	Henry's Law Constant (@20-25° C) (atm-m^3/mol)	Henry's Law Constant (@20-25° C) (L-H_2O/L-air)	Diffusion Coefficient in Air (D^{air}, cm^2/s)	Diffusion Coefficient in Water (D^w, cm^2/s)	Adsorption Coefficient (Koc, mL/g)	Vapor Pressure (@20-25°C) pure compound (mm Hg)	Aqueous Solubility pure compound (@20-25°C) (mg/L)
Benzene	78.1	5.29×10^{-3}	0.22	0.093	1.1×10^{-5}	38.0	95.1	1750
Toluene	92.4	6.25×10^{-3}	0.26	0.085	9.4×10^{-6}	134.9	28.4	535
Ethylbenzene	106.2	7.69×10^{-3}	0.32	0.076	8.5×10^{-6}	95.5	9.6	152
Xylenes (mixed isomers)	106.2	6.97×10^{-3}	0.29	0.072	8.5×10^{-6}	239.88	5.76	198
Naphthalene	128.2	1.18×10^{-3}	0.049	0.072	9.4×10^{-6}	1288.25	0.23	32.9

Chemical	Cancer Slope Factor Oral (SF_o, kg-day/mg)	Cancer Slope Factor Inhalation (SF_i, kg-day/mg)	Reference Dose, Oral (RfD_o, mg/kg-day)	Reference Dose, Inhalation (RfD_i, mg/kg-day)
Benzene	0.029	0.029	-	0.0017
Toluene	-	-	0.2	0.114
Ethylbenzene	-	-	0.1	0.286
Xylenes (mixed isomers)	-	-	2.0	2.0
Naphthalene	-	-	0.004	0.004

TABLE B.3

Equations Used to Develop Tier 1 RBSLs

1. Groundwater Ingestion:

   a. Carcinogens

$$RBSL_{water}\ (mg/L\text{-}H_2O) = \frac{TR \times BW \times AT_c \times 365\ days/year}{SF_o \times IR_{water} \times EF \times ED}$$

   b. Non-Carcinogens

$$RBSL_{water}\ (mg/L\text{-}H_2O) = \frac{THQ \times RfD_o \times BW \times AT_{nc} \times 365\ days/year}{IR_{water} \times EF \times ED}$$

2. Soil (subsurface) Leaching to Groundwater:

$$(N)RBSL_{soil}\ (mg/kg\text{-}soil) = \frac{RBSL_{water}\ (mg/L\text{-}H_2O)}{LF_{s\text{-}w}}$$

3. Leaching Factor, soil to groundwater:

$$LF_{s\text{-}w} = \frac{\rho_b}{[\delta_{ws} + (Kd* \times \rho_b) + (H \times \delta_{as})] \times [1 + (U_v \times \delta_{gw})/(I \times W)]}$$

Kd* = Koc X TOC

1990; Lyman et.al, 1990), and between C_{10} and C_{24} for diesel fuels (Hess, 1979; Dunlap and Beckmann, 1988; California, 1989; Nyer and Skladany, 1989; ORNL, 1989). Each compound has different and sometimes uncertain properties of solubility, adsorption, vapor pressure, toxicity, and other properties.

Weathering generally removes compounds less than C_8 from a gasoline mixture, which results in an accumulation of C_8 and C_9 compounds (Johnson, et al., 1990). Because compounds less than or equal to C_9 are considered toxic (Bossert and Bartha, 1984), TPH as a whole contains compounds that may be individually or collectively hazardous to human and environmental health. Limited risk and toxicity data for TPH exists as a whole.

In general, residual TPH remaining from weathered fuels is comprised of low-mobility compounds with higher molecular weight ($>C_8$), higher adsorption coefficients, and lower solubility relative to the C_3 to C_6 compounds (Dragun, 1988; Kostecki and Calabrese, 1989; Nyer and Skladany, 1989; Johnson, et.al., 1990). Therefore, many uncertainties exist that make determining screening levels for TPH a difficult task, requiring careful consideration and research.

2. ***TPH in Groundwater***: Because of the uncertainties concerning the toxicity and associated risk of TPH, the UDEQ/LUST evaluated different methods for determining appropriate TPH screening levels. The UDEQ/LUST decision for the TPH NRBSL of 10 mg/L is based on the following conservative assumptions: (1) The TPH as gasoline is from only weathered fuel, and contains 3% benzene; (2) The TPH as diesel is only slightly weathered and contains 1% naphthalene (California, 1989; Nyer and Skladany, 1989; ORNL, 1989; Lyman et.al, 1990); and (3) Motor oil degrades very slowly and is enriched in C_{20} to C_{60} compounds.

   Using the above assumptions, the following methods were used for determining NRBSLs for TPH in groundwater.

   a. The most conservative method of gasoline-related calculating TPH assumes that when the RBSL for benzene in groundwater (0.3 mg/L) is present, the concentration of TPH is represented ratio of the benzene RBSL to its percentage in TPH is 10 mg/L. Similarly, diesel-related TPH can be estimated from the ratio of the RBSL for naphthalene in groundwater (0.1 mg/L) to its percent composition of diesel. These relationships are shown in equations 2.1.a and 2.1.b

below:

Equation 2.1.a $$\frac{RBSL_{benzene-GW}}{Weight\ \%_{benzene/gasoline}} = \frac{0.3\ mg/L}{0.03} = 10\ mg/L\ TPH\text{-}gasoline$$

Equation 2.1.b $$\frac{RBSL_{naphthalene-GW}}{Weight\ \%_{naphthalene/diesel}} = \frac{0.1\ mg/L}{0.01} = 10\ mg/L\ TPH\text{-}diesel$$

The resulting TPH screening levels are considered conservative because contaminant attenuation due to biodegradation or dispersion is not factored in.

b. Analytical Modeling: Analytical modeling experiments were performed by UDEQ/LUST (1995) using the groundwater modeling program SOLUTE (Beljin, 1991) to observe the extent and degree of a plume containing 10 mg/L dissolved TPH. For consistency, the conservative fate and transport conditions used in the equations for developing the RBSLs (Table B.3) were also used in the model. The only chemical-specific parameter required by the SOLUTE model is retardation, for which a conservative adsorption coefficient of 1200 mL/g (EPA, 1988; Lyman, et.al., 1990) was used. No degradation due to contaminant decay is assumed. The model predicted that due to the relatively high adsorption and retardation of the constituents that comprise TPH, a localized plume of dissolved TPH forms and gradually dissolves and attenuates near the source. The model output data indicate that a continuous source concentration of TPH of 10 mg/L directly entering groundwater for 10 years decreases within the source area by 2 orders of magnitude.

3. ***Total Petroleum Hydrocarbons (TPH) in Soil***: The soil NRBSLs for TPH as gasoline and diesel, and TRPH/Oil and Grease (1500, 5000, 10000 mg/kg, respectively) were derived using equations 2 and 3 in Table B.3. The TPH-gasoline NRBSL was double-checked using an indicator chemical.

The soil NRBSL for TPH as gasoline was determined using the following 2 methods: Method 1: Calculate the NRBSL using equations 2 and 3 in Table B.3, and; Method 2: Numerical modeling that simulates gasoline contaminants leaching to groundwater using the indicator compound 1,3,5-Trimethylbenzene (1,3,5-TMB). The NRBSL for diesel TPH and NRBSL for

heavy motor oils (total recoverable petroleum hydrocarbons, TRPH) were developed using Method 1 primarily because numerical modeling predicted virtually no leaching to groundwater, and thus may not be sufficiently protective.

a. Method 1: Assuming the soluble, degradable BTEX compounds are weathered out, the composition of gasoline TPH was estimated to be 53% (weight percent) aromatics from C_8 to C_{12} and 47% aliphatics (mostly n-alkanes) from C_9 to C_{24}. The soil NRBSL can be back-calculated by first calculating the leaching factor (equation 3, Table B.3). The leaching factor was derived by using average adsorption coefficients and Henry's Law Constants for the aromatic and aliphatic constituents for each product type. The calculated average leaching factor for gasoline is 0.0067. Using the same logic, a calculated leaching factor for diesel is 0.002 and 0.001 for heavy motor oils. Equations 2.2 through 2.3, below, present the final screening level:

Equation 2.2
$$NRBSL_{soil} = \frac{NRBSL_{TPH-GW}}{LF_{TPHgasoline}} = \frac{10\ mg/L}{0.0067} = 1500\ mg/kg\ TPH-gasoline$$

Equation 2.3
$$NRBSL_{soil} = \frac{NRBSL_{TPH-GW}}{LF_{TPHdiesel}} = \frac{10\ mg/L}{0.002} = 5000\ mg/kg\ TPH-diesel$$

Equation 2.4
$$NRBSL_{soil} = \frac{NRBSL_{TRPH-GW}}{LF_{TRPHoil}} = \frac{10\ mg/L}{0.001} = 10{,}000\ mg/kg\ TRPH-oil$$

b. Method 2: Soil TPH concentrations can be estimated by simulating the concentration of TPH that leaches 10 mg/L TPH to groundwater. Method 2 uses the numerical model VLEACH 2.0 (Ravi and Johnson, 1993) was used (UDEQ/LUST 1995) to simulate the leaching of an indicator chemical of TPH from the adsorbed-phase in the vadose zone to groundwater. The indicator chemical selected represents the

bulk of TPH. The modeling was corroborated by Jenkins (1995). The numeric modeling method requires: (1) Simulating a representative indicator chemical because numeric models require input of constituent-specific properties, which prohibits modeling of TPH as a whole, and (2) Estimated soil concentration of that indicator chemical.

A representative and conservative indicator chemical, 1,3,5-Trimethylbenzene (1,3,5-TMB), is used. 1,3,5-TMB is representative of residual TPH because it comprises up to 10% by weight of a typical gasoline mixture, up to 5% of weathered gasoline, and over 3% of diesel (Johnson, et.al., 1990; Lyman, et.al., 1992; Knox, et.al., 1993). It is also a known common environmental contaminant in residual TPH based on data in UDEQ/LUST case files. 1,3,5-Trimethylbenzene is a C_9 hydrocarbon (alkylbenzene) with potentially high solvent membrane toxicity (Bossert and Bartha, 1984), and high volatility and explosive potential. The suggestions found in Gilbert and Calabrese (1990) were considered when selecting 1,3,5-TMB as an indicator compound of TPH.

The objective to determine what TPH concentration in soil will leach 10 mg/L to groundwater begins with the indicator chemical. First, the most conservative value of 10% 1,3,5-TMB in gasoline is assumed and the following relationship is established:

Equation 2.5 $$10\%\ 1,3,5\text{-}TMB \times 10\ mg/L\ TPH = 1\ mg/L\ 1,3,5\text{-}TMB$$

Equation 2.5 implies that 1 mg/L 1,3,5-TMB will be present when TPH is 10 mg/L.

The next step is to determine what concentration of 1,3,5-TMB in the a soil will leach 1 mg/L 1,3,5-TMB so that a soil TPH concentration can be back-calculated. Several model runs were performed in which the soil concentration of 1,3,5-TMB was varied until 1 mg/L TMB leaching to groundwater was achieved (UDEQ/LUST, 1995). The model predicted that when 1,3,5-TMB is between 130 mg/kg and 170 mg/kg (average 150 mg/kg), 1 mg/L 1,3,5-TMB leaches to groundwater. A soil TPH NRBSL using Method 2 is then back-calculated, as follows:

Equation 2.6

$$\frac{150\ mg/kg\ 1,3,5\text{-}TMB}{10\%\ 1,3,5\text{-}TMB/TPH} = 1500\ mg/kg\ TPH$$

The NRBSL, 1500 mg/kg, is 85% lower than the concentration of TPH that is visible as residual liquid in sediment pore spaces. Once again, all parameters used in VLEACH are identical to those used in the RBCA spreadsheet (Table B.1). The chemical properties of 1,3,5-Trimethylbenzene are shown in Table B.4.

Table B.4

Chemical Properties of 1,3,5-Trimethylbenzene[1]

Aqueous Solubility mg/L	Adsorption Coefficient mL/g	Diffusion Coefficient in Air m^2/day	Henry's Law Constant (dimensionless)
70	1200	0.52	0.09

[1] from Brookman, et.al., 1985; EPA, 1991; Lyman, et.al., 1992.

IV. EXPOSURE SCENARIOS

Exposure scenarios are characterized by exposure pathways, exposed populations, exposure duration, and intake assumptions. The exposure equations (Table B.2) assume that during a given exposure duration, such as 30 years, an individual of a given weight, dermal surface area, and consumptive capacity will be exposed to the concentrations calculated by the equations (Table B.3).

A. Exposure Pathways: The exposure pathways evaluated in Utah's RBCA process are the most common pathways and routes of exposure and were therefore used for developing the RBSLs.

1. Groundwater ingestion.

2. Soil leaching to groundwater to be ingested.

The groundwater pathway assumes that when the RBSL is confined to the source area, the ingestion exposure pathway is not complete and receptors are not likely to be exposed to contamination. The soil-leaching-to-groundwater pathway is calculated from the RBSL in the groundwater divided by the leaching factor, which describes the potential of contamination to leach to groundwater and attain the groundwater RBSL.

Excluded from Tier 1 evaluations are other exposure pathways including: vapor inhalation caused by contamination in soil and groundwater volatilizing into homes and other enclosed spaces via foundation cracks or openings; dermal absorption, and; construction worker scenario where dermal exposure, vapor inhalation, and particulate inhalation are the primary exposure pathways. The RBSLs calculated for the excluded pathways are not appropriate for Tier 1 screening purposes because the resulting RBSLs are either excessively high or below laboratory detection limits due to the uncertainties associated with the contaminant fate and transport for those pathways. While the UDEQ/LUST is not ignoring those pathways, past experience with over 2000 reported releases throughout the State indicate that those exposure pathways are commonly not complete. The use of RBSLs for those pathways would therefore not be reasonable for screening purposes. However, if the site assessment information indicates that other exposure pathways are complete and receptors are threatened, appropriate abatement response actions may be necessary and cleanup standards would be developed for those pathways.

B. Exposed Populations (Land Use): The most sensitive population setting used in Utah's Tier 1 RBCA process is residential. Exposure to individuals in the residential population setting is for human adults weighing 70 kg (154 lb) with a dermal surface area of 3.2E+03 cm^2 that consume 2 liters per day of potentially contaminated water over a period of 30 years at home.

C. Exposure Duration: The ASTM default exposure duration values were not changed. The exposure duration calculations assume that adults described above ingest contaminated groundwater, in the residential setting for 30 years.

D. Exposure Intake: The ASTM default value, ingestion of 2 liters per day (Table B.1) is the standard assumption for water ingestion in residential settings for adults.

V. GROUNDWATER AND SOIL PARAMETERS

A. Groundwater Parameters:

1. Groundwater Mixing Zone Thickness: This parameter can be thought of as the upper portion of the aquifer that receives the contamination leaching from a LUST via the vadose zone, plus any additional thickness attributed to a fluctuating groundwater level. The ASTM default value for this parameter of 200 cm (6.6 ft) accurately reflects Utah's groundwater fluctuation levels.

2. Groundwater Infiltration Rate: This parameter is the rate at which recharge water infiltrates the subsurface and potentially mobilizes sorbed-phase contamination. The groundwater infiltration rate should be 10-20% of a region's average annual precipitation. The ASTM default value is 30 cm/yr (12 in/yr) and is more characteristic of regions that experience 40 to 60 in/yr total precipitation. 20% of the precipitation (14 in/yr) in Utah's intermontane basins is 3 in/yr, however a conservative infiltration rate of ***6 in/yr*** was used in the calculations to account for artificial recharge such as irrigation or sprinkling.

3. Groundwater Velocity: This is the most sensitive parameter in the calculations because:

   * It can vary by orders of magnitude in short distances due to the uncertainty and variability of hydraulic conductivity, and;

   * It drives the leaching factor equation and governs the amount of mixing that contamination undergoes in the aquifer. Therefore, low groundwater velocities result in very slow mixing and increased retention time near a source. An RBSL calculated using low velocities is generally the most conservative.

   The ASTM value of 82 ft/yr was changed to a conservative ***35 ft/yr*** which is derived from average Utah-representative hydraulic conductivity of about 5 ft/day, hydraulic gradient 0.007 ft/ft, and 38% porosity.

B. Soil Parameters

1. Capillary Zone Thickness: The ASTM value of 2 in (5 cm or 0.16 ft) was changed to ***3 ft*** based on data from UDEQ/LUST case files.

2. Vadose Zone Thickness: The ASTM value of 9.68 ft was changed to ***4 ft*** based on data from UDEQ/LUST case files.

3. Depth to Groundwater: The ASTM value of 9.8 ft was changed to ***7 ft*** based on data from UDEQ/LUST case files..

4. Depth to Contaminated Soil: The ASTM value of 3.28 ft was changed to ***6 ft*** based on data from UDEQ/LUST case files.

5. Fraction of Organic Carbon Content (TOC): The ASTM default value for this parameter is 1%, but a conservative Utah-specific value of ***0.5%*** is used.

APPENDIX C

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UTAH DERR/LUST RELEASE AND INITIAL "RBCA" SITE ASSESSMENT REPORT

Release Site No. _____ Date Received_____
Facility ID No. _____ Date Assigned_____
Project Manager _____ Date Confirmed_____
Potential PST Funded Site?_____ Spill Report/Info received by_____

Name of reporting party _____ Company _____ Phone:_____
Name of RP (current o/o) _____ Phone:_____
Name of Release Location _____ Phone:_____
Release site street address _____ City:_____

Type of Release: ____ (piping: suction/pressurized) ____ tank (corrosion/fittings) ____ spill/overfill ____ pump island
Age (Years) and Construction of Tank(s) _____, Piping _____
Release Date(s) _____ **Suspected or Confirmed?** Estimated Amount _____
Method of Determination: ___ failed TTT (volumetric/other) w/ leak rate of _____ gal/hr; ___ Leak Detector Alarm
___ Inventory loss (_____ gal); ___ failed LTT (volumetric/other) w/ leak rate of _____ gal/hr
___ Field Instrumentation (Model/Type _____) w/ maximum readings of _____ units
___ Permanent Closure (in-place/removal) w/ ___ soil staining; ___ odors; ___sheen on H_2O; ___ Analytical
___ Analytical Results; Soil (mg/Kg) B____, T____, E____, X____, N____, TPH____, O&G____, TRPH_____
___ Analytical Results; Water (ug/L) B____, T____, E____, X____, N____, TPH____, O&G____, Solvents____ Substance
Released: ___ Gas (UL/Reg) ___Diesel ___Waste Oil ___New Oil ___Other (specify)_____
Native Soil Type _____; Depth to contaminated soil (ft below grade)_____
Depth to Groundwater (GW) (ft below grade) _____; Local/Regional GW flow dir. _____/_____
Slope direction of local topography _____; Separation distance from soil contamination to GW (ft) _____
Distance/Direction to nearest water well (ft) _____/_____; Dist./Dir. to nearest surface water (ft) _____/_____
Dist./Dir. to nearest utility conduits (ft): ___/___Water; ___/___Sewer; ___/___Gas; ___/___Storm drain; ___/___Electric
Dist./Dir. to nearest structure/building (ft): _____/_____; Dist./Dir. to nearest property boundary (ft)_____/_____
Current Land Use: _____Residential; _____Commercial; _____Industrial; _____Other (describe)_____
Surrounding Land Use:_____Residential; _____Commercial; _____Industrial; _____Other (describe)_____
Misc.: Annual precipitation (inches/year) _____; Ground Cover at Site; _____

RELEASE IMPACTS

FUMES: ___Home***** ___Business***** ___Utilities***** ___Outdoors ___Soils ___Water ___Other (specify)_____
DAMAGE: ____Soils ____ Groundwater (~_____ft BLS) ____Surface Water***** ____Drinking Water***** ____Utilities*****
____Land Surface***** ____Biota/Wildlife***** ____Free Product***** ____ 3rd party impacts*****
Utah State Risk Manager notified of 3rd party impacts (direct/potential) on: ____/____/____by:_____
Agencies Notified/On-Site:___LHD ___DEQ/DERR ___DEQ/DE ___Fire Dept. ___EPA ___Other_____
**** May indicate the need for emergency abatement action(s) & other agency involvement***

INITIAL ABATEMENT/CORRECTIVE ACTION PERFORMED

Estimated volume of contaminated soil removed/left in-place (cubic yards or tons)_____
Disposal location used _____
Number and type of confirmation samples collected _____
Estimated volume of contaminated groundwater removed (gallons)_____
Disposal location used _____
Number and type of confirmation samples collected _____
Was the extent and degree of contamination defined (Yes/No)? If "No", describe future work planned at the site:
_____
_____
_____
_____
Staff Recommendations:_____
_____
_____
Attach site map showing depths, locations & results of all environmental samples collected as well as other relevant info.